logistically be implemented in the current spectrum environment. The presence of multiple co-channel users, off-set channel assignments, inter-channel interference, and low power or point-to-point offset users creates an interesting challenge for re-farming of the current spectrum.

Digital radios such as ASTRO based on 12.5 kHz FDMA systems are ideally suited to address the real world issues of spectrum congestion and user requirements. Because FDMA systems are not constant carrier systems, they can co-exist with wide band and existing offset channel assignments. They will allow for graceful migration of congested and cluttered frequencies with potential mixing of different bandwidth systems during a transition period. They will also allow users to migrate within current bands, and not force them to abandon their current systems or move to new bands.

Motorola's ASTRO radio design offers multiple modes of operation to assure that users can migrate without immediately obsoleting their current investments in analog systems. With this capability, users can plan for migration to digital services on a radio-by-radio basis, a channel-by-channel basis, or in large geographic systems on a region-by-region basis. In the radio-by-radio method, analog field units or base stations can be replaced with digital radios as systems expand. The new radios would operate in an analog mode on existing 25 kHz or 30 kHz channels and their digital capabilities lie dormant until enough

operate with each other in the digital mode and with the older units in the analog mode. The timing of this kind of gradual unit cut-over to digital will be a function of the planning and budgeting cycles, and service needs of each organization.

These are only some of the technologies and potential impacts of the coming digital radio era. The power and flexibility of these new radios will redefine how the industry looks at communications. This redefinition will offer users new capabilities, flexibility, versatility and spectrum efficiency. The industry will have a tremendous opportunity to improve land mobile communications, if the Commission moves to a 12.5 kHz channeling plan supportive of this new digital technology.

V. THE COMMISSION'S PROPOSED MIGRATION PLAN WILL CAUSE HARMFUL INTERFERENCE TO MILLIONS OF CURRENT LAND MOBILE USERS

The Commission has proposed a migration path to more efficient technology for private land mobile users operating below 512 MHz that would require existing users to reduce the amount of spectrum that they occupy in two distinct steps. First, users in the 150 MHz band would be required to reduce their occupied bandwidths to 12 kHz by January 1, 1996, and then, beginning in the year 2004, these licensees would need to further reduce their occupied bandwidths to 4 kHz.[7] Likewise, in the UHF

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[7] See proposed rule § 88.433 in the Notice.

land mobile bands, existing licensees would be required to first reduce their occupied bandwidths to 10 kHz by January 1, 1996, and then to 5 kHz beginning in the year 2004.

The major problem with the Commission's proposal is that it does not provide a graceful transition to new technology for existing users. For instance, the first phase of the transition would require existing licensees to reduce frequency deviation in order to occupy less bandwidth. For most existing equipment, however, such a modification will seriously degrade the users' quality of service. Reducing frequency deviation will reduce the system's signal-to-noise ratio at the receiver and therefore reduce voice intelligibility. Also, reducing the frequency deviation will remove as much as 50 percent of the tone squelch decoder margin which could lead to system failure.

Furthermore, reducing the occupied bandwidth of the transmitted signal will not allow new users to occupy the newly created "talk paths" because radio system receivers will continue to operate over a wide bandwidth and thus "hear" the adjacent channel operations. In other words, without a corresponding reduction in receiver selectivity, new operations introduced on

allowed to operate adjacent to the current equipment operating in these bands. The results, described below, show the Commission's proposed migration plan would cause significant destructive and harmful interference to existing users.

At VHF, the Commission proposal would place the first interleaved 5 kHz channel 10 kHz from a current assignment. With 10 kHz spacing, a 5 kHz (4 kHz emission bandwidth) linear transmitter would provide only 18 dB of adjacent channel protection into the millions of 25 kHz VHF receivers in use today. In contrast, the current operation of 25 kHz equipment on 15 kHz channel centers in this band provides approximately 30 dB of adjacent channel protection. Even worse, the second interleaved channel spaced 5 kHz away from current assignments as proposed would essentially be a cochannel interferer.

In the UHF band, the Commission proposal would place a 6.25 kHz channel only 9.375 kHz from the current primary full power assignment and only 3.125 kHz from the current low power offset user. The adjacent channel protection of a 6.25 kHz (5 kHz emission bandwidth) linear transmitter into the current 25 kHz receivers spaced 9.375 kHz away would be only 10 dB compared to today's protection of 70 dB between adjacent 25 kHz full power primary channels. The current low power offset user would experience the new 6.25 kHz operation as a full powered cochannel interferer. In fact, the Commission's plan places two 6.25 kHz assignments essentially cochannel to today's offset users. Such a plan would cause harmful interference to the millions of

primary and offset users already operating the UHF band. Because many existing receivers do not allow for adjustments in selectivity, any true improvement must be achieved through the installation of new equipment.[8]

In short, the Commission should not assume that the first step in its transition plan to more efficient technology is a simple modification of existing transmitters that would impose little cost on users. Any significant improvements in spectral efficiency must come through the deployment of new equipment. To this end, Motorola now provides its specific recommendations for a transition to more spectrally efficient technology in the private land mobile bands.

VI. MOTOROLA RECOMMENDED MIGRATION PLAN

Motorola believes that the Commission's refarming goals are better achieved by requiring all users in both the VHF and UHF bands to use "true" 12.5 kHz equipment. Employing 12.5 kHz

efficiently used bands will become even more efficient with a higher grade of service at a minimal cost to users. Motorola provides the following specific recommendations:

A. 150-174 MHz:

VHF high band is currently channelized with 15 kHz spacing between frequency assignments. The equipment, however, is designed for operation on a channel spacing of 30 kHz or 25 kHz. While all frequencies are utilized in most major urban areas, adjacent channels are generally assigned with geographic separation to help reduce adjacent channel interference. This spacing has been reduced over the years as a result of increasing demand for those VHF frequencies.

Motorola recommends that the Commission take steps to transition the VHF high band to 12.5 kHz equipment on channels spaced every 12.5 kHz apart. In so doing, new systems authorized after the effective date of the future Report and Order in this proceeding should be required to purchase "true" 12.5 kHz equipment. These systems would be assigned two frequencies of operation; a 15 kHz frequency from today's list of assignable frequencies and an adjacent future use 12.5 kHz frequency. These new licensees could immediately commence operation with their 12.5 kHz equipment on the 15 kHz channels but, at some future date, would be required to retune to the future-use 12.5 kHz channel. Retuning from 15 kHz channels to the adjacent 12.5 kHz channel carrier frequency would be a minor equipment adjustment

and would not involve any of the problems detailed above. Such a step would also provide approximately 100 new channels.

Figure 1 shows a group of six channels spaced 15 kHz apart. Retuning from 15 kHz to 12.5 kHz channels is best viewed within six channel groups. As can be seen from this figure, users on channels 1 and 6 would not be required to retune while users on channels 2 and 5 would be required to shift their carrier frequency 2.5 kHz, while users on channels 3 and 4 would shift their carrier frequency 5 kHz.

Again, this equipment modification will not be burdensome to users. Equipment is available that will operate on the assigned 15 kHz frequencies but be readily moved to the new 12.5 kHz assignments. In fact, synthesized equipment probably would be pre-programmed to operate on the future-use 12.5 kHz channels since users would know those frequencies at the time of grant.

Existing users should be required to convert their systems to 12.5 kHz operations at the same time the newer licensees are required to retune their operations. The deadline for this complete changeover should be established with the amortization schedules of the existing users in mind. Motorola recommends a ten year amortization period which would result in all users converting to the 12.5 kHz band plan by the year 2004.[9] For

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[9] During this interim period, existing users should be able to continue purchasing add-on or replacement units compatible with their current 25 kHz radios. However, the Commission should establish a date after which equipment that cannot be readily converted to 12.5 kHz operation would no longer be type accepted. Motorola recommends that this date be January 1, 1996.

150 - 174 MHz
12.5 KHz Frequency Plan

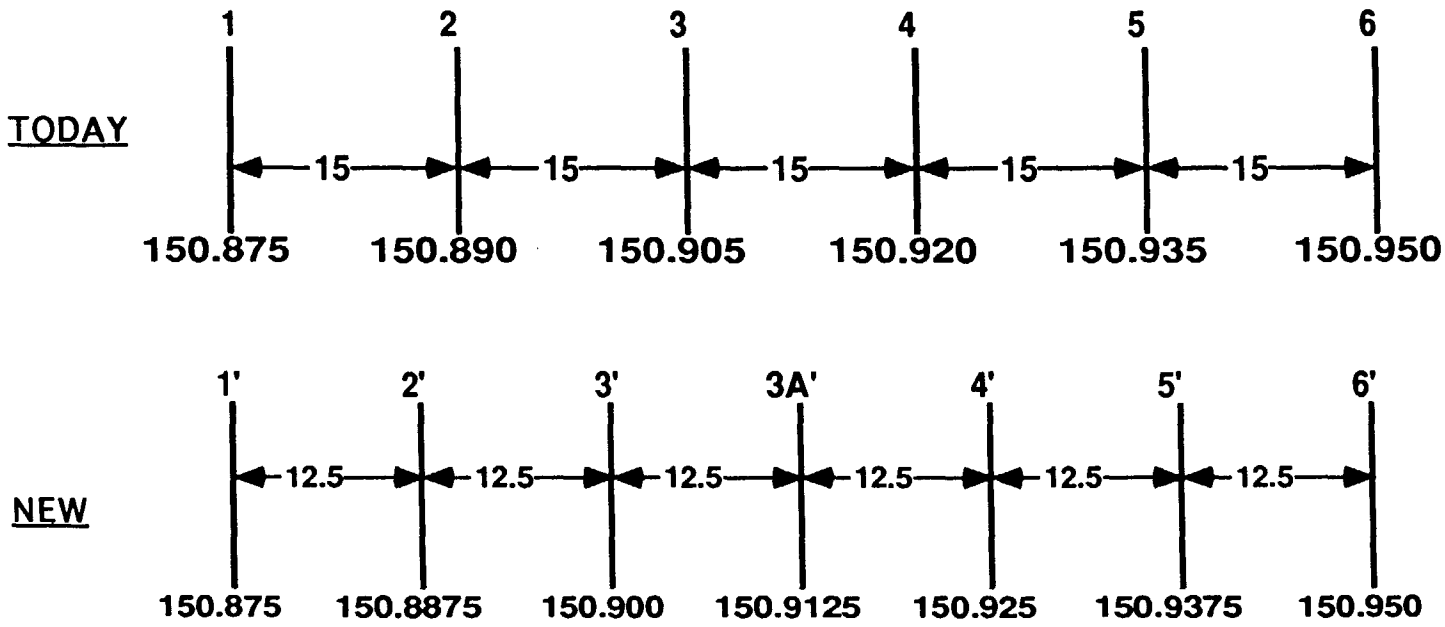

Figure 1

existing users, conversion to 12.5 kHz should be optional but those who choose not to convert would become secondary as of that date.[10]

Adoption of a 12.5 kHz channeling plan need not preclude the use of 6.25 kHz equipment if users so desire. Motorola recommends that the Commission allow for 6.25 kHz equipment by creating assignable channels that are offset by 3.125 kHz from the center frequencies of 12.5 kHz channel. Users could voluntarily split 12.5 kHz assignments and replace them with two 6.25 kHz assignments. As an alternative, users could migrate to 6.25 kHz equipment on the same channel center by deploying systems that are backward compatible with their 12.5 kHz equipment. After the equipment changeout was completed the user would shift to one of the offset assignments and create an extra 6.25 kHz channel for his/her own use or for use by others.

B. 421-470 MHz:

Motorola's proposal for the transition to more efficient technology in the UHF band is similar to its proposal for VHF systems. New UHF systems authorized after the effective date of the Report and Order in this proceeding should be authorized a

recommended for VHF operations. Existing users should be required to convert their existing equipment to 12.5 kHz equipment gear in accordance with a ten year amortization schedule. Thus, a complete migration to a 12.5 kHz channeling plan would be completed by the year 2004, or possibly sooner.

The complicating factor in the UHF band is the existing low power secondary systems operating on the 12.5 kHz offset channels in the 450 - 470 MHz band in accordance with Section 90.267 of the Rules. Motorola recommends that the Commission upgrade these operations to primary status, reserving some channels for low power itinerant operations, and designating the remaining offsets for full power coordinated systems as users deploy true 12.5 kHz

operation satisfies the Commission standards for spectrum efficiency and technical flexibility.

C. **470 - 512 MHz:**

In the 470 - 512 MHz bands that the land mobile services share with broadcast television, the Commission should establish a 12.5 kHz channeling identical to that recommended for the 450 - 470 MHz band. New licensees should be required to immediately use 12.5 kHz equipment and existing users should be required to transition to 12.5 kHz operations by the year 2004. The assignment of channels offset by 12.5 kHz from today's existing 25 kHz channel could begin immediately upon the adoption of the Report and Order provided that the user employs 12.5 kHz

government operations throughout the VHF and UHF bands thus facilitating a common equipment approach and interoperability between state and local and Federal agencies. Further, this plan will allow sharing among Federal and nonfederal users in

In this matter, Motorola fully supports the Consensus Report of the Land Mobile Communications Council (LMCC) which contained a more flexible approach in regulating the technical parameters of private land mobile stations. The LMCC submitted tables of varying ERP and HAAT levels that would allow applicants to choose the combination of facilities that best satisfies their own individualized coverage requirements.[13] In addition, the LMCC recommended that applicants requiring greater coverage and higher powered facilities be able to submit coverage maps showing that the requested combinations of ERP and HAAT provide the minimum necessary field strength over the intended area of operation.[14] [15]

To fully underscore the impact of the Commission's height and power proposals of the Commission's Notice, Motorola has prepared a series of coverage maps that are attached in Appendix B. These maps depict the devastating impact of the Commission's

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[13] These tables, based on R6602 propagation curves, provide a useful format even if the Commission and industry ultimately decide in this proceeding that alternative propagation models yielding different limits are more appropriate.

[14] The LMCC recommended that the Commission define service area range in the VHF band as the 37 dBu contour and the 39 dBu

proposals in terms of coverage area from today's permissible ERP and HAAT combinations.

Map 1 shows the coverage area of a high powered base station operating with the following parameters that are permitted under today's rules:

BASE STATION ERP:	304.3 Watts/54.83 dBm
BASE STATION HAAT:	1147.6 Feet
SYSTEM TALK-OUT COVERAGE:	See Attachment 1
SYSTEM TALK-IN COVERAGE:	See Attachment 2

Map 2 shows the corresponding mobile station talk-in coverage area using 100 watt mobile units and 2 dB gain antennas. The two maps show that radio coverage is balanced; that is, talk-out coverage is almost identical with talk-in coverage.

Map 3, however, illustrates base station radio coverage from the same antenna structure using the following parameters taken from the FCC's Notice:

BASE STATION ERP:	5 Watts/37.0 dBm
BASE STATION HAAT:	1147.6 Feet
SYSTEM TALK-OUT COVERAGE:	See Attachment 3

As one can see, radio coverage is no longer balanced, the talk-in coverage area exceeds the talk-out range. (Note that the talk-in coverage would remain the same as that shown in Map 2.)

Comparing Map 1 with Map 3 indicates an approximate 67 percent reduction in talk-out radio coverage area. Under the proposed height and power limitations, Motorola estimates that at least four sites will be needed to maintain service throughout the original coverage area. If this redesigned system needed to maintain mobile to mobile communications throughout the entire service area which was available under the single site

configuration, then the four site system would need to route communications originating at any one site to all of the other sites for retransmission to the mobile units. One method to accomplish this would be to deploy a simulcast system where the same RF channel is employed at all base locations.

Simulcast systems require very high stability and precise RF frequency devices for all base stations, special base station and audio network equipment, and a distribution network (e.g., microwave links) to maintain the correct frequency response and stability over the necessary audio bandwidth. Although simulcast systems are spectrum efficient, they are very expensive compared to the single site UHF repeater configuration. For example, four base transmitters would be needed, each at a higher cost than standard base stations. Further, linking these sites together by microwave would add even greater costs just to maintain the same coverage as today. Motorola estimates that the cost would be several orders of magnitude greater than that of a single site system.[16] It would also require the use of additional microwave frequencies at a time when current 2 GHz microwave spectrum is being redeveloped for new emerging mobile technologies such as PCS.

Alternatively, the four sites could each operate on different RF channels if available. Although less complicated than a simulcast system, the base stations would still require

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[16] This estimate covers only the price of hardware and does not include installation fees, maintenance, site leasing or other recurring costs.

some means of interconnection and routing so that wide area communications could be maintained. Significantly more costly than a single site system, such a multi-site approach is also not as spectrum efficient as it requires four mobile frequencies and possibly fixed microwave frequencies as well. Such a system design would more than offset any perceived efficiency improvement resulting from a power decrease.

Finally, the Commission must realize that land mobile users tailor coverage to meet operational requirements, not to hamper co-channel operations. Providing this coverage, whether through single sites or multiple sites, will define co-channel reuse. Multiple sites required as a result of regulatory power limitations only add unnecessarily to the cost.

VIII. EMISSIONS MASKS AND FREQUENCY STABILITY

Motorola has been working with the Telecommunications Industries Association (TIA) in formulating emissions masks for digital narrowband transmissions in support of APCO Project 25.[17] In its comments to this proceeding, TIA submitted its recommendation for general Part 90/88 emissions masks for 12.5 kHz and 6.25 kHz equipment. The masks are intended to apply to both digital and analog equipment. Motorola fully supports the comments of TIA and reproduces the recommendation in Appendix C.

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[17] APCO Project 25 is developing standards for digital public safety land mobile equipment.

As noted in TIA's comments, these emissions's masks better serve the public interest than the Commission's proposed criteria because they accommodate every known piece of 12.5 kHz land mobile equipment manufactured today. This equipment has already been used with great success in other countries and their use should not be precluded here. Motorola therefore urges the FCC to adopt the TIA proposed emissions masks.

Likewise, Motorola supports the TIA's comments in regard to its recommendations for frequency stability requirements. The proposals, reproduced in Appendix D, will provide manufacturers with needed design flexibility while providing adequate interference protection to users. Motorola therefore urges the Commission to adopt the TIA proposals relating to frequency stability.

One final note, however, the Commission has proposed a new requirement in proposed Section 88.425 which would require the frequency stability requirements to apply 20 milliseconds after the initial power transmission that is 20 dB below the final output power. Since there is no discussion on this rule change, Motorola assumes that its intent is to limit transients during the transmitter ramp-up time and thus limit interference from spurious emissions. Motorola supports the Commission's actions in this regard and points out that the EIA/TIA have already addressed the issue of transient frequency behavior in its publication SP-22108. Motorola believes that since the industry

has already addressed this matter through the adoption of voluntary standards, an FCC rule is unnecessary.

IX. CONCLUSION

Motorola supports the Commission's goal of achieving higher spectrum efficiency within the private land mobile bands below 800 MHz. These bands, however, are heavily used workhorse bands currently supporting a broad range of critical private land mobile communications requirements. The equipment operating in these bands represents a staggering user investment of $25 million.

As discussed in these comments, any transition plan to more spectrum efficient technologies must ensure the continuous availability of reliable, cost-effective, communications for public safety, public service, industrial and business users. Further, transition timing should consider the natural cycles of equipment usage and retirement.

Very narrow band system are yet unproven in the real world. Accordingly, there is no rational basis upon which to mandate that private land mobile users implement very narrow band equipment. Motorola recommends the Commission adopt our alternative migration plan based on 12.5 kHz channels at both the VHF and UHF bands. Such a plan achieves significant improvements in spectrum efficiency and allows users to choose the best technology to meet their needs. In conjunction with this plan,

Motorola also provides alternative emissions masks and frequency stability recommendations which should be adopted.

In addition, Motorola urges the Commission to adopt the alternative power limit structure set forth in the consensus plan previously filed by the Land Mobile Communications Council and discussed in these comments. This plan incorporates the necessary flexibility to match power and cochannel protection with a user's requisite coverage area, which varies considerably among the broad range of land mobile installations.

TAB A

APPENDIX A

MOTOROLA LAND MOBILE PRODUCTS PORTFOLIO

Motorola's product portfolio of mobile, portable, base station and special application equipment for use in the 150-174 MHz and 450-512 MHz bands is comprised of 35 model families. A model family includes all frequency bands, all transmitter power levels and all major options, e.g., clear versus secure operations.

There are numerous individual models within each model family which identify the specific characteristics of a given

Synthesized FM Portable Radio

- MT1000 Series "Handie-Talkie"
  Synthesized FM Portable Radio
- HT50 Series Synthesized Portable Radio
- Systems SABER Portable Radio
  For Securenet or Smartnet II Systems
- MAN DOWN Two Way Portable Emergency Radio
- HT1000 Synthesized FM Portable Radio
- HT2000 Synthesized FM Portable Radio
- SABER I, II and III Conventional Portable Radios
  Clear and Securenet Capable Models
- MTS 2000 Portable Radios
  for Secure & Advanced Conventional and Trunked Systems
- "PAC-TL" Vehicular Repeater System
  for Conventional Portable/Trunked Mobile
- Systems 9000 VRS Vehicular Repeater System
- "PAC-TR" Vehicular Repeater System for
  Conventional Portable/Trunked Mobile Multiple Vehicle Applications
- SECURENET Portable Repeater
  Clear and Coded Operation
- PAC-RT Portable/Mobile Vehicular Repeater System
- PAC-PL Portable/Mobile Vehicular Repeater System
- SVA Transportable/Mobile Base Stations
- Spectra-TAC
  Satellite Receiver Voting System
- SECURENET Digital Voice Protection System
  "Spectra-TAC" Voting System
- PURC Radio Link
  Transmitters/Repeaters
- MSF 5000 SECURENET Capable
  Base Stations and Repeaters

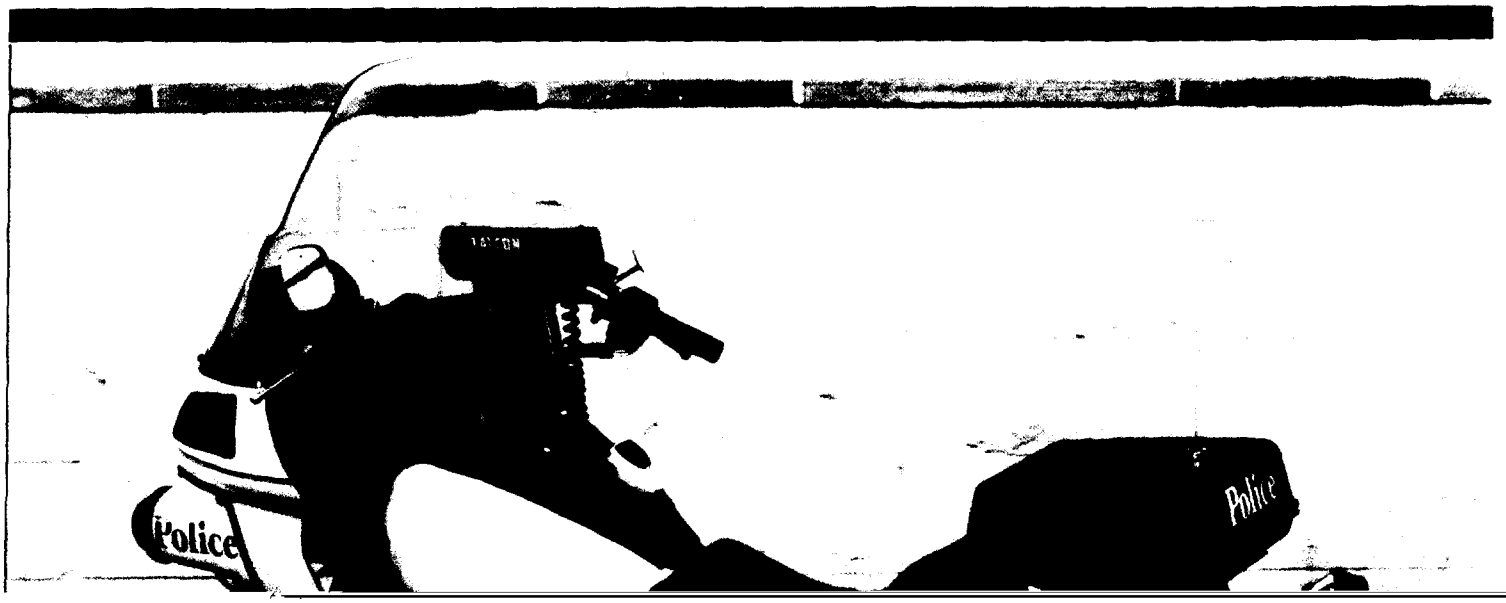
- MSR 2000 Base Stations and Repeaters
- DeskTrac
  Conventional Desktop Stations
- SPECTRA Desktop Stations
  for use in SMARTNET Trunked and Advanced
  Conventional Systems
- INTRAC 2000 System
  Modular Remote Terminal Unit Plus
- INTRAC 2000 System
  Modular Remote Terminal Unit
- MOSCAD
  Motorola SCADA Remote Terminal Unit

MOTOROLA

SPECTRA

Motorcycle Radio Featuring Securenet Capable Models

136-174 MHz
438-470 MHz
800 MHz SMARTNET



SPECTRA Motorcycle Radio

Performance Specifications

General

No. of Modes:	128 (Conventional) 20 Trunked Channels, 10 Conventional Modes (Smartnet)
Squelch Option:	Carrier squelch, Private-Line and Digital Private-Line codes are standard and available within the same radio unit.
Primary Power:	13.6V Nominal, Negative Ground
Channel Resolution:	Multiples of 5.0 kHz or 6.25 kHz

Std. Models (Series)	Factory ID	"Securenet" Model (Series)	Factory ID	Frequency Range (MHz)	Minimum RF Power Output	Receive Current @ Rated Audio	Transmit Current @ Rated Power	Standby Current
MA4KM/075W MA5KM/075W MA7KM/075W	M33KMA M33KMA M33KMA	MA4KX/075W MA5KX/075W MA7KX/075W	M33KXA M33KXA M33KXA	136-162, 146-174	15W	2.5A	3.5A	.5A
MA4KM/076W MA5KM/076W MA7KM/076W	M34KMA M34KMA M34KMA	MA4KX/076W MA5KX/076W MA7KX/076W	M34KXA M34KXA M34KXA	438-470	15W	2.5A	4.5A	.5A
MC5KG/077W MC7KG/077W	M35KGA M35KGA	MC5ZX/077W MC7ZX/077W	M35ZXA M35ZXA	806-824 Tx, 851-869 Tx Rx	15W	2.5A	6A	.5A

Transceiver Dimensions and Weight

	Transceiver	Weatherproof Enclosure
Enclosure	**15W**	
Length in. (mm):	8.6 (218.4)	15.0 (381.0)
Width in. (mm):	7.1 (180)	13.5 (343.0)
Height in. (mm):	2.0 (51)	6.3 (160.0)
Weight Lb. (kg):	5.5 (2.5)	14.8 (6.7)

Transmitter

Output Impedance:	50 ohms
Frequency Stability:	±0.0005%; optional ±0.00025% 800 MHz: ±0.00015% From −30°C to +60°C ambient (+25°C reference)
Spurious & Harmonics:	70 dB below carrier
Modulation:	(16F3) ±5 kHz (16KOF3E, 16KOF1D, 15KOF2D)
Audio Sensitivity:	80 mV nominal for 60% system deviation ± 3 dB
Audio Response:	+1/−3 dB from 300 to 3000 Hz
Audio Distortion:	3% @ 1000 Hz 60% Max deviation

	VHF	UHF	800 MHz
FM Noise:	−50 dB	−45 dB	−40 dB
Frequency Separation:	26 or 28 MHz	32 or 30 MHz	18 MHz

Environmental Performance

Standard	Method	Test	Radio Performance
MIL 810E	514.3 516.3	Vibration Shock	Meets or exceeds published specifications following vibration

Weather Resistant Methods

Standard	Method	Procedure	Test
MIL 810E	505.2	II	Solar Radiation
	506.2	I	Rain
	507.2	I	Humidity
	509.2	I	Salt Fog
	510.2	I	Blowing Dust
	508.3		Fungus

Note: Spectra radios also meet or exceed all requirements for MIL STD 810C and 810D.

Security

Encryption Type:	Digital
Coding Method:	Multi-register non-linear combiner
Number of Codes:	Dependent on encryption options
Synchronization:	Self synchronizing or counter addressing
Code Key Initialization:	Internally derived pseudo-random initializing vector
Code Key Generator:	External hand held microprocessor controlled key variable loader
Code Storage:	Volatile electronic memory
Analog to Digital Conversion:	Continuously Variable Slope Delta Modulation (CSVD)
Voice Sample Rate:	12 K bit/Sec

Control Head Dimensions and Weight

(Depth) Length in. (mm):	2.3 (58.4)
Width in. (mm):	7.1 (180.0)
Height in. (mm):	2.0 (51)
Control Head lb. (kg):	0.8 (0.4)
Microphone lb. (kg):	2.9 (1.3)
Speaker lb. (kg):	1.7 (0.77)

Receiver

Audio Output:	10 watts @ 3% distortion
Input Impedance:	50 ohms
Frequency Stability:	+0.0005%; optional ±0.00025% From −30°C to +60°C ambient (+25°C reference)

Receiver Band	VHF		UHF		800 MHz
Channel Spacing:	25 kHz or 30 kHz		25 kHz		25 kHz
	STD. No Preamp	OPT. Preamp	STD. No Preamp	OPT. Preamp	STD. No Preamp
Sensitivity EIA SINAD:	.35 μV	.2 μV	.35 μV	.2 μV	.3 μV
Spurious & Image Rejection:	−90 dB	−85 dB	−90 dB	−85 dB	−90 dB
Intermodulation EIA SINAD:	−85 dB @ ±25 kHz	−80 dB @ ±25 kHz	−83 dB @ ±25 kHz	−80 dB @ ±25 kHz	−80 dB @ ±25 kHz
Selectivity:	−85 dB @ ±25 kHz −90 dB @ ±30 kHz		−85 dB @ ±25 kHz		−80 dB @ ±25 kHz
Max. Frequency Separation:	26 MHz Range 1 28 MHz Range 2		32 MHz		18 MHz

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